Isotope Production Calculations Using FISPIN

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WANDA 2021

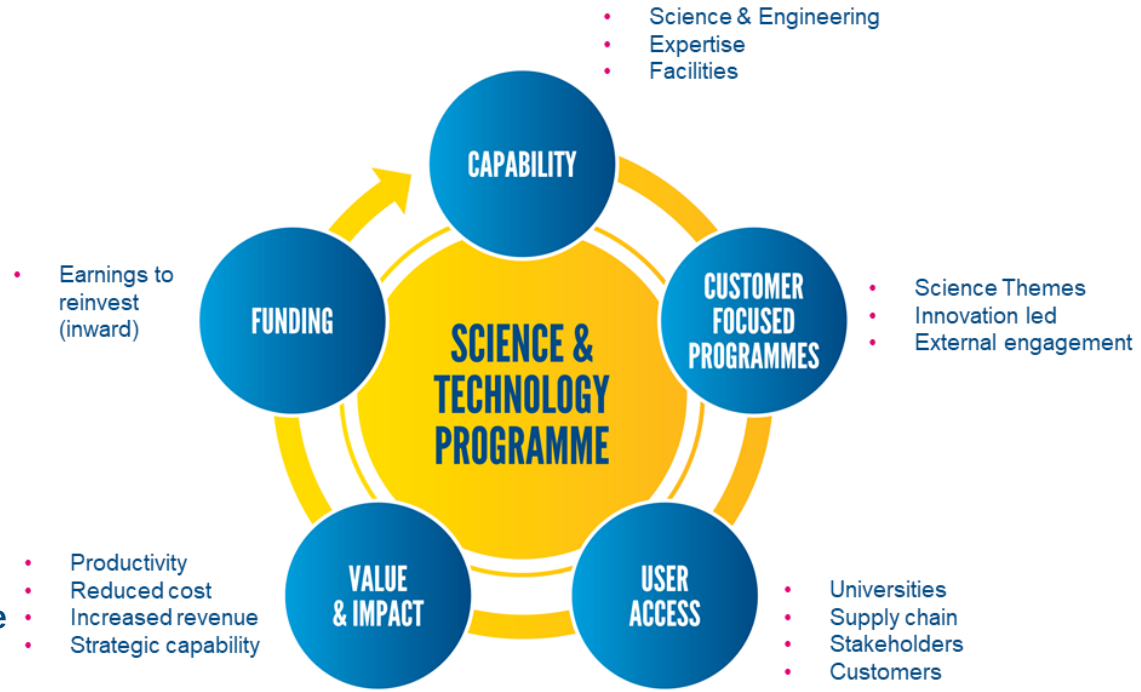
NATIONAL NUCLEAR LABORATORY

ABOUT NNL

- NNL is the UK's National Nuclear Laboratory which operates on an autonomous commercial basis
- NNL is owned by the UK government and has three roles prescribed to it, shown in the figure opposite
- NNL operates world leading facilities doing world class science
- Over 10,000 person years of nuclear industry experience across the whole fuel lifecycle
- 6 locations across the UK including high active laboratories
- Principal customers include: Sellafield Ltd, EDF Energy, Ministry of Defence, BEIS, Westinghouse, US Department of Energy, Nuclear Decommissioning Authority (NDA)

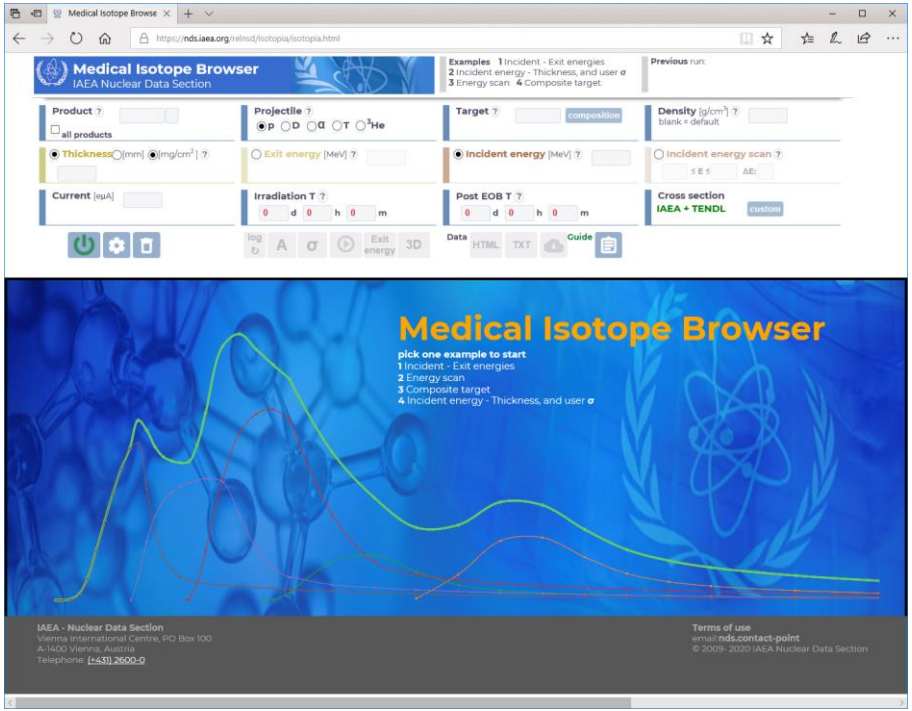
NNL'S CORE SCIENCE THEMES

- ~£1.8m investment per year in Core Science Themes
- 9 Core Science Themes, enabling NNL to:
  - **Develop expertise**
  - **Work with the supply chain**
  - **Build strategic capability on behalf of the UK**
- Advanced Recycle and Isotope Separation (ARIS)
  - **Identified growth areas include the use of accelerator-based systems for isotope production**



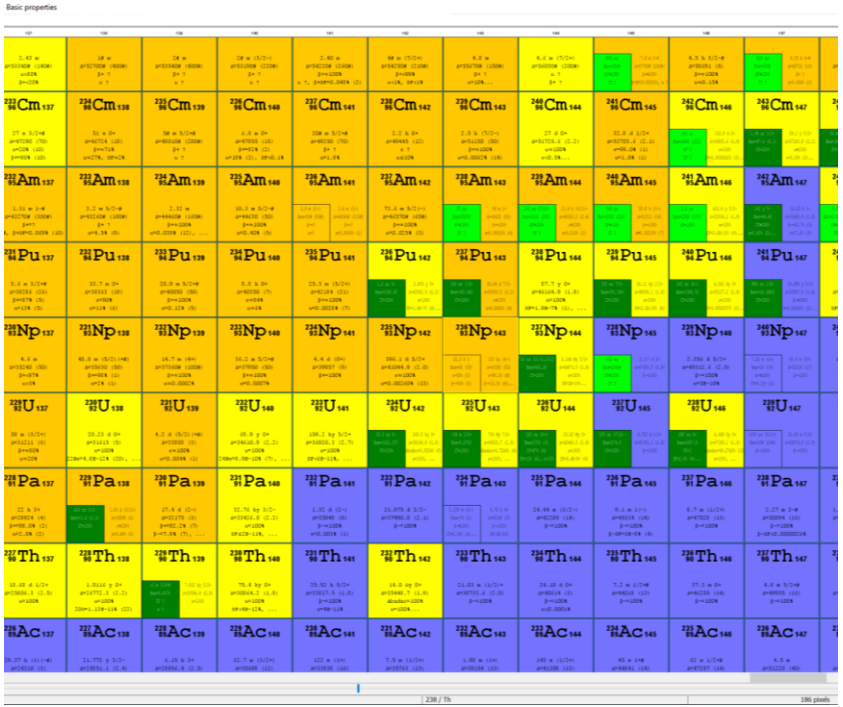
ACCELERATOR ISOTOPE PRODUCTION

- Accelerator based isotope production has tended to focus on charged particle sources
- Some tools have been created (ISOTOPIA) that can make conversion assessments for these reactions
- More recent interest in neutron induced isotope production from accelerator based systems
  - **Replace research reactors**
  - **Cheaper (commissioning and decommissioning)**
  - **Fewer safety implications**
  - **Less waste and less hazardous wastes**



ACCELERATOR PRODUCTION – WHERE IT STARTS

- Nuclear data provides a wealth of information to tap into but can be difficult to utilise
- With so much data available, it can take a lot of work to sift through and understand possible production routes from an idea
- Everything is possible, but how likely are the interactions we want? And what might be the downfalls of a production route? What else do we end up with?

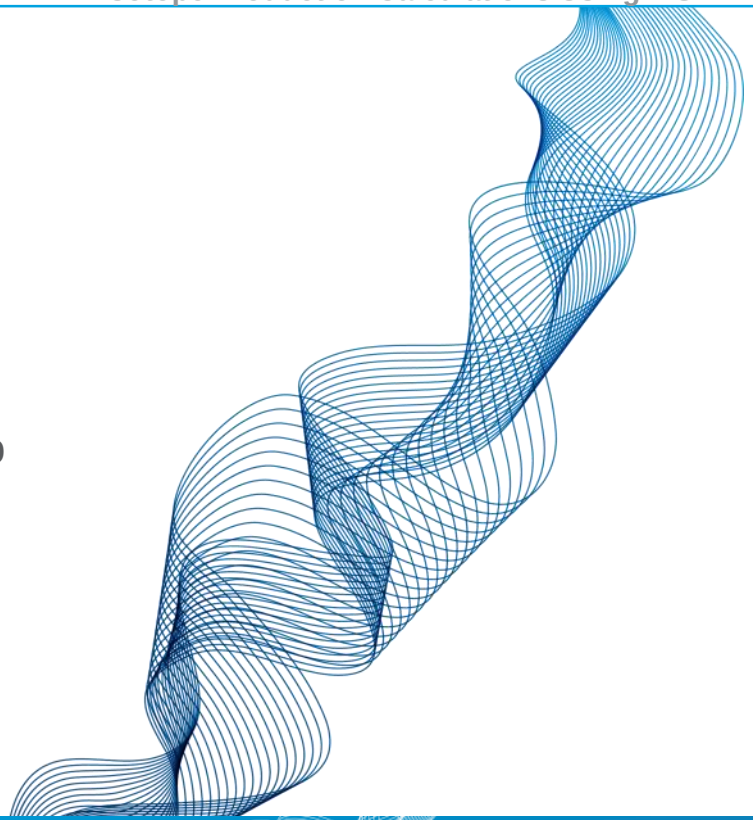


ASSESSING CONCEPTS

- Given the manual nature of such assessments, they're currently dependent on the knowledge of subject matter experts, and to complete in detail require significant time – we're limited to "back of envelope calculations" for most discussions

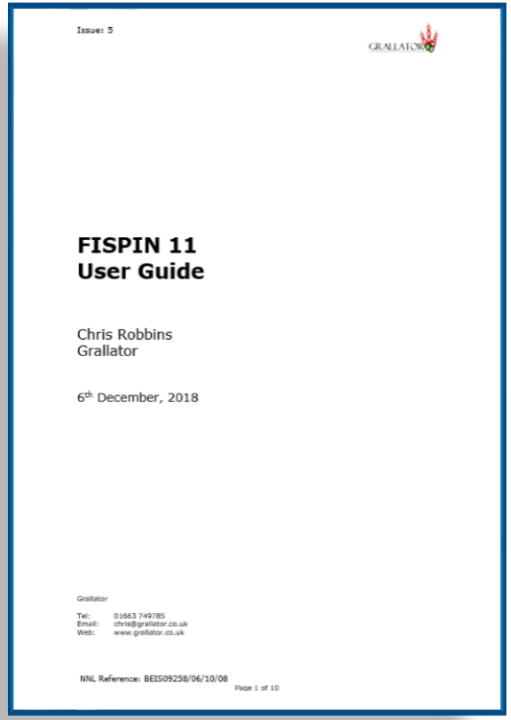
- There are plenty of ideas of what could be done with an accelerator for isotope production – building an expertise in assessing their viability would allow us to prioritise based on theoretical feasibility

- **Enter the "Production Rate Assessment Tool"!**



FISPIN11

- FISPIN is a standard code used in the UK over the last 60 years to calculate the composition and evolution of irradiated nuclear fuel and related waste streams
- FISPIN11, has been in development for approximately 4 years and was a complete re-write of the FISPIN solution method
- The code can now track more decay chains than we've ever been able to track previously
- FISPIN11 has a number of improvements over its predecessor, including:
  - **Improved efficiency**
  - **Improved ease of use and maintenance**
  - **Inclusion of the updated FISGUI (FISPIN Graphical User Interface)**
  - **Increased flexibility (wrapper capability)**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GRALLATOR

FISPIN 11
User Guide

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Grallator

6th December, 2018

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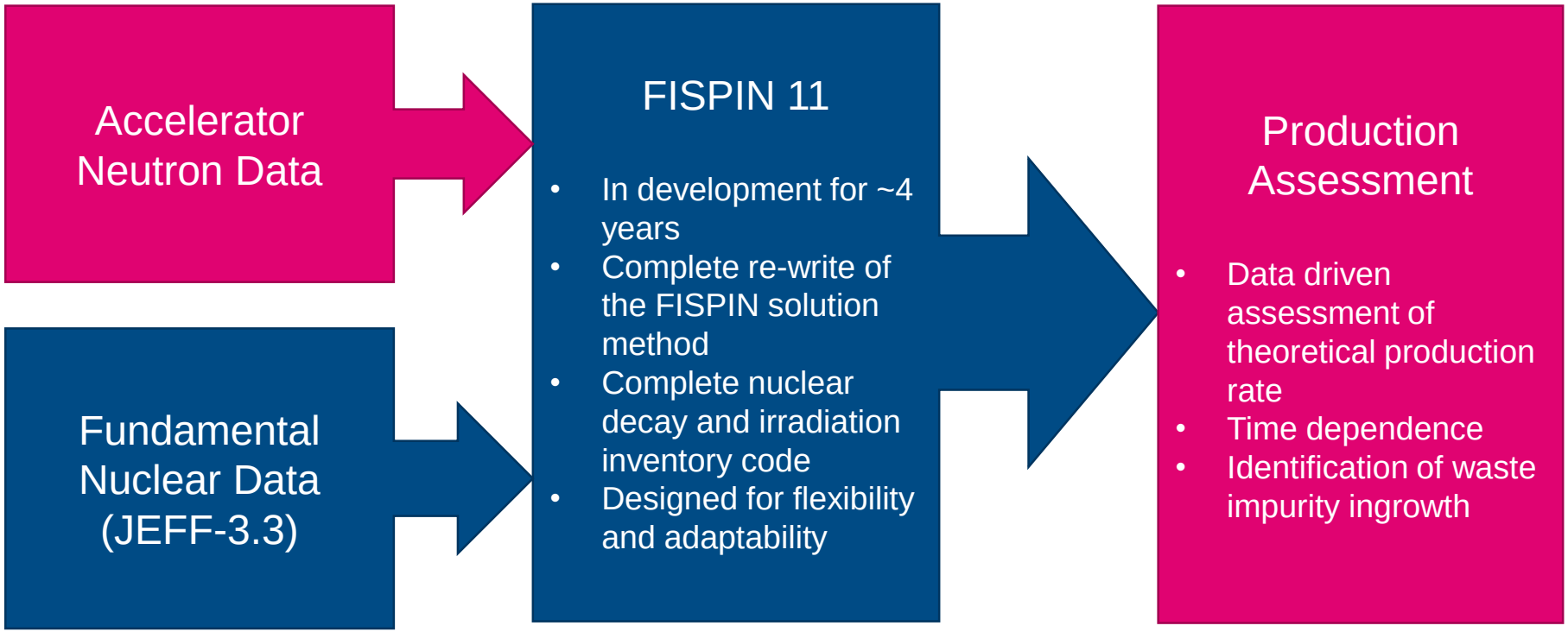
ARCHITECTURE

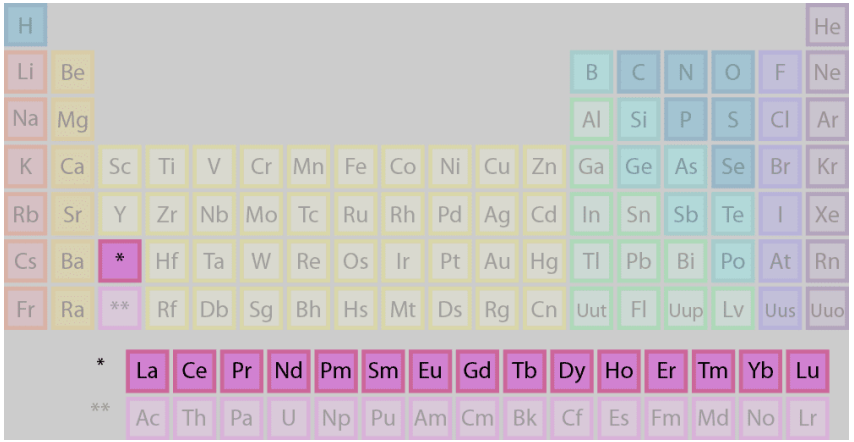


NUCLEAR DATA

- Models are no longer limited by computational capabilities, but by the uncertainties in nuclear data
  - **Nuclear decay data**
  - **Neutron transmutation cross-sections**
- Any uncertainty from FISPIN11 will come from the fundamental nuclear data
- Some data is less tested for accelerator applications
- The tool will be very reliant on the quality of the underpinning nuclear data

DEVELOPMENT AIMS

- In development (2020-2021)
- Develop initial Production Rate Assessment Tool FISPIN wrapper
  - **Key assumptions – thin targets, neutron only sources**
  - **Methodology for handling accelerator based neutron energy spectrum**
- Collate baseline accelerator information – neutron energy ranges, fluence
- Assess performance on initial concepts – lanthanides from EURO-GANEX
  - **Process developed for co-separating transuranium elements from irradiated nuclear fuels**
  - **Aims to identify which lanthanide feeds would be a suitable source of useful isotopes**



Thank you for listening!

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